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PROGRESS IN HONEY UTILIZATION

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I would like to tell you today what we are doing with honey at Philadelphia, why we are doing it, and something of what we have done.

The Eastern Regional Research Laboratory is one of four such laboratories of the Bureau of Agricultural and Industrial Chemistry. As our Bureau Chief, Dr. G. E. Hilbert, told the Senate Appropriations Committee this spring, the Bureau is concerned with three main problems. One of these concerns research on the conversion of perishable commodities to a stable, palatable, convenient-to-use form. The second main problem concerns the lowering of the cost of processing agricultural commodities to narrow the spread between the farmer and the consumer. The third main problem concerns the development of new and extended uses for agricultural commodities.

Honey research would seem to fall in the latter two categories, especially the last one. Honey was not one of the commodities included in the original program, which has been under way for about twelve years. Not until 1948, as a result of industry request, was honey research begun at this Regional Laboratory. The Bureau had been engaged in research on honey since the time of Harvey W. Wiley before the turn of the century, and between 1928 and 1943 a sustained honey research program was being carried out in Washington. This was interrupted during the war and began again in 1948 at Philadelphia. The transition from the war-time sellers' market in honey had been rather abrupt, and the industry found inventories high, especially in the lower grade, darker, stronger flavored honeys, and a considerable carry-over from year to year.

The Department was requested to investigate methods of eliminating this surplus of strong-flavored honey, and our first project was the study of methods of modifying or completely removing the flavor of such honey. This work was under the direction of Mr. G. P. Walton until his retirement in December of 1949.

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[1] One of the laboratories of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Service, United States Department of Agriculture.

After a considerable period of experimentation, involving hundreds of small-scale processing tests, two methods of flavor modification were recommended in a bulletin issued in May 1950.[2]

In an effort to find a use for deflavored honey syrup in which no other sugar product could be substituted, we investigated the possibility of producing a fruit-flavored spread [3] which depended for its texture on the fine-grained crystallization familiar to honey people in "creamed" or "Dyce-processed" honey. It was found possible to make such a product using a variety of fruit juices and purees, combined with deflavored honey evaporated in vacuum to honey density, seeded and crystallized as in the honey-spread processes. Manufacture by this procedure required the use of a vacuum pan, not a common piece of equipment in honey processing although some plants are so equipped.

On further consideration, we made a number of samples of fruit spread using normal, good-flavored honey rather than deflavored honey. By reducing the amount of fruit it was found possible to obtain a product with a pleasing combination of fruit and honey flavor. Some of the fruit flavors tried were raspberry, strawberry, grape, apricot, pineapple, peach, loganberry, and orange. If the juices of these fruits are used as the fruit component of the spread, they cause considerable dilution of the honey with water so that evaporation is required to return the mixture to a suitable water content to allow the crystallization to take place. There is no reason that this evaporation could not be done before mixing with honey. In fact, by using suitable fruit juice concentrates the manufacture of the crystallized honey-fruit spread could be carried out with a minimum of equipment. It then is possible to mix the concentrate with honey in a suitable proportion, heat to pasteurize, cook, seed, and crystallize.

The problem then becomes the location of suitable commercial sources of fruit juice concentrates.

A process for manufacturing improved juice concentrates was developed a few years ago at this laboratory. In this process, using special equipment, the juice is stripped of its volatile flavor constituents which can be concentrated a hundred times or more. The residual juice which has been so treated is then concentrated by the usual means to a high density, then the concen-

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[2] J. W. White, Jr. and G. P. Walton, "Flavor Modification of Low-Grade Honey", AIC-272, Eastern Reg. Res. Lab., BAIC, May 1950.

[3] J. W. White, Jr., "New Crystallized Fruit Spread Shows Commercial Promise", Food Ind. 22, No. 7, 84 (1950).

trated flavor fraction, or "essence" as it has been termed, is added back to the concentrate in suitable proportions to make a product which when diluted back to single-strength gives a product substantially the same as fresh juice.

Such a concentrate would be ideally suited for fruit spread manufacture, since the essence fraction would contribute the delicate flavor notes which ordinarily may be lost in the evaporation method of making the spread. Such juice concentrates are now available commercially. One honey packer is now in production on honey-fruit spreads, and an eastern preserve manufacturer is planning to make trial runs.

We have been granted a patent on the process which is assigned to the Secretary of Agriculture and is available for use on a royalty-free, revocable, non-exclusive basis.[4]

Since the honey research program of the Bureau is operating under limited budgetary and personnel conditions, we have tried to extend our programs by cooperative efforts with other governmental laboratories and by contracting with outside organizations for research and development. Under the Research and Marketing Act of 1946, authority was granted to contract for certain research with organizations outside the Department provided the public interest was best served thereby. If it is shown that a program can be carried out more expeditiously and at less cost, we may arrange a research program to be carried out by contract with a suitable, selected outside organization.

As an example of cooperative effort within the Department, we have been working with the Dairy Research Laboratories of the Bureau of Dairy Industry. In this project, which has been largely carried out at the BDI laboratories in Washington, methods have been developed for manufacture of three concentrated honey-milk products.[5] It has long been thought that one of the deterrents to the wider use of honey in manufacturing has been the general difficulty of handling the material due to its physical nature. A dry honey should have wide applicability in the food field. A step in this direction is the production of a dry honey-skim milk product, composed of 40% honey solids and 60% nonfat milk solids. This material, a white, free-flowing, fine powder with a pleasant honey-milk flavor, can be manufactured by methods developed in this cooperative study.

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[4] U. S. Patent 2,573,750; Nov. 6, 1951.

[5] G. P. Walton, J. W. White, Jr., B. H. Webb, C. F. Hufnagel and A. H. Stevens, "Manufacture of Concentrated Milk and Honey Products", Food Tech. 5, 203 (1951). U. S. Patent 2,621,128; Dec. 9, 1952.

Two other honey-milk products have been developed, a honey-sweetened condensed milk and an evaporated milk fortified with honey. These products are easily manufactured and show adequate storage stability. It is possible that products of this nature might find application in infant feeding, provided research on this application would be so indicative.

Since we are not equipped at the laboratory to do research in baking, we have placed three research contracts dealing with various phases of the role of honey in commercial baking at one of the country's outstanding baking research laboratories. Under the first two contracts much interesting and potentially useful information has been obtained.

We have, in talking with experts in commercial baking, often heard the statement that an important factor holding back the greater use of honey in large-scale commercial baking is the nonuniformity of the product. One of the objectives of the research contracts, which were placed at Kansas State College, was to find out exactly how much uniformity is needed for honey so that its full potentialities in baking might be realized. Another purpose, of course, was to find any possible advantages that might be related to the use of honey in commercial baking.

Under the first contract that was supported in part by the American Beekeeping Federation, breads, cakes and yeast-raised sweet goods were studied. I can give you only a brief review of the results, which have appeared in five articles, four of which were published in baking trade journals.[6]

In the first contract, it has been found that honey of suitable floral source may be used at the 3% or 6% level in large-scale commercial production of white and whole-wheat breads without change of production methods. A majority of a taste panel detected honey in bread at the 6% level in a statistically controlled experiment. When honey was substituted for one-third of the sugar in white and yellow cakes a significant improvement

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[6] L. B. Smith and J. A. Johnson, "The Use of Honey in Cake and Sweet Doughs", Bakers Digest 26, No. 6, 113 December (1952).

L. B. Smith and J. A. Johnson, "The Use of Honey in White and Whole Wheat Bread", Amer. Bee Jour. 93, 118, 164 (1953).

L. B. Smith and J. A. Johnson, "Honey—Its Value and Use in Popular Cookies", Bakers Digest 27 (2), 28 April (1953).

L. B. Smith and J. A. Johnson, "Honey Improves Fruit Cake Quality", Bakers Digest 27 (3), 52 June (1953).

L. B. Smith and J. A. Johnson, "The Use of Honey in Bread Products", Bakers Digest 25, No. 6, 103 December (1951).

Reprints of these articles may be obtained from Kansas State College, Manhattan, Kansas, or the Eastern Regional Research Laboratory, Philadelphia 18, Pa.

in flavor, "eating quality," and moisture retention resulted. Fruit cakes showed greatly improved slicing quality after storage when honey was substituted for sucrose. Desirable flavor, color, and aroma factors were introduced when honey was employed in yeast-raised sweet goods.

Fifteen fruit cakes, each containing different floral types of honey, were stored for 110 days and evaluated by an organoleptic panel for aroma, flavor, and crumbliness. Cakes containing honey ranked generally higher for all factors after 110 days' storage when compared with cakes made with sucrose only.

In commercial baking, the greatest potential increases in the use of honey should be possible in the categories of cakes and cookies, especially the chewy types. In the second research contract, a study was made of the role of honey in cookie production. Six typical cookies, representing the two principal types (brittle and chewy) were included. The optimum degree of replacement of other sweetener by honey without change of type characteristic was determined. The optimum honey level was found to be as follows (in terms of percent of flour weight) : sugar cookies, 5%; ginger snaps, 30%; vanilla wafers, 5%; coconut macaroon chips, 13.3%; fruit bars, 66.6%; and brownies, 50%.

In storage studies, it was found that honey had no effect on oxidative rancidity after 108 days' storage, and that some increase in breakage resistance in stored cookies was imparted by honey.

A study of the effect of floral source of honey on the acceptability of the various cookies was carried out, including fifteen floral types. In taste panel judging, honey had the most consistent approval in the chewy type of cookies, such as macaroons, fruit bars, and brownies, where eating quality as well as color and flavor was improved.

It has been found that in the procurement of honey for use in commercial baking, the only important properties that must be considered are flavor and color. Thus, when a baker wants uniformity in honey, he wants to be able to expect various lots to be of a flavor (and, for some baked goods, color) similar to previous successful batches. Elementary, you may say, what else is there? Actually, it has been suggested by people in the baking industry and some who know honey that maybe such things as levulose-dextrose ratio, acidity, colloids, or enzymes might have some effect on uniformity from the baking standpoint. Fortunately, this does not appear to be the case.

While the experimental baking work was all done at Kansas State College, we were responsible for the chemical analysis of the honey samples which were used. In doing this work we have learned something about the analysis of honey for the various sugars. Now methods of analysis of honey for the sugars present has not changed in any important way for around fifty years. These are times of great technical change in nearly all fields, and the field of sugar analysis is no exception. Being relative newcomers, we had no long experience in this particular subject, so since we had a number of authentic samples for analysis, we analyzed them by five different procedures for the sugars dextrose and levulose. The results were somewhat dismaying to us. We could not get any two of the methods to give us the same results on the same sample. Since we felt that some of the difficulty might be due to our inexperience, we analyzed the results statistically. The conclusion to which we came was that there was more variation among the results of different analytical methods on the same honey sample than would show up among different floral sources of honey analysis by the same method.[7]

The methods in use for the determination of sugars in honey belong in general to the class termed "empirical" methods. That is, the answers obtained may not necessarily be truly representative of the composition of the sample, but if carried out in exactly the same way on a number of samples, the results will give a useful picture of the relationship of one sample to another.

Thus, the fact that the five methods of analysis which we studied all gave different results should perhaps be expected. This does not make the situation any less annoying, because we do not have any idea which, if any, of the procedures gives results closest to the actual composition of the sample.

This situation has led us to develop an entirely new procedure for the sugar analysis of honey. Now, for the first time, it appears to be possible to analyze a honey sample with confidence that the results actually reflect the true composition of the sample. The method is too involved to describe here, except perhaps to say that we begin by filtering the honey sample through a column of finely divided charcoal which separates it into three solutions which contain sugars of different degree of complexity.

For the past several years we have been cooperating with John Haynie in analyzing tupelo honey samples. There does not seem

[7] J. W. White, Jr., C. Ricciuti, and J. Maher, "Determination of Dextrose and Levulose in Honey", J.A.O.A.C. 35, 859 (1952).

to be much information in print regarding the sugar distribution of tupelo honey. When anything is found, it is usually a reprint of the information published by Dr. C. A. Browne of our Bureau in 1908, forty-five years ago. Dr. Browne reported that tupelo honey contained twice as much levulose as dextrose. As you know, dextrose is the sugar in honey which crystallizes out when honey granulates. Levulose is a simple sugar that is much more soluble and tends to keep the dextrose in solution. Tupelo honey never granulates because of the high amount of levulose, or perhaps we should say the low amount of dextrose it contains.

In the past three years we have analyzed twenty-nine samples of tupelo honey from four crop years. These analyses have all been done by the same method (not the new one I have just mentioned). The samples were collected by Mr. Haynie, and some of you in the audience have furnished samples.

There are two points of interest in the results of these analyses. The first is that, of these twenty-nine samples over four years, none has approached the levulose content reported by Dr. Browne forty-five years ago and more or less accepted as standard for tupelo honey.

The second point is the remarkable agreement among samples from various producers and also the close agreement of the averages from year to year. The average dextrose content for the three years that Mr. Haynie has sent samples was 1951, 28.6%; 1952, 28.7%; and 1953, 29.0%. For levulose, the averages are 1951, 44.2%; 1952, 44.0%; and 1953, 43.8%. The average annual range of values is about 2.2% dextrose and 2.0% levulose.

As you are well aware by now, I am not talking about the subject which John Haynie assigned to me, "Factors and Characteristics Typical of Honey in the South." The big reason for this is that from the point of view of a chemist, or a food technologist, we don't know much about southern honey. Aside from a few tupelo and one gallberry honey samples, we have not had an opportunity to analyze honeys typical of the southern part of the country. We would like to analyze by our new method samples of such honeys as sourwood, mangrove, partridge pea, Florida orange, saw palmetto, cabbage palm, and other commercially important southern honey types.